DETERMINING DISCOUNT RATE IN IRAN AND ITS ROLE IN RESOURCE ALLOCATION.

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THESIS

DETERMINING DISCOUNT RATE IN IRAN AND
ITS ROLE IN RESOURCE ALLOCATION

by

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Determining Discount Rate in Iran and Its Role in Resource Allocation

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ABSTRACT

Definitions, concepts, the rules for investment decision, and the method to compute the rate of return and the social discount rate are presented. By taking the historical data in industrial, services and agriculture sector in Iran the rate of return as an indicator of the social discount rate is computed. Then the role of the social discount rate in resource allocation and its role in economic growth and public sector investment are presented.

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I. INTRODUCTION

A. BACKGROUND

Iran's economic development is based on target goals, policies and guidelines set by the national plan. The plans are dynamic and formulated on the basis of twenty year perspective plans, defined in more detail as five year plans, and budegeted annually. The plans cover all social and economic sectors with targets, directives and programs for both public and private sectors.

Planning in Iran was institutionalized in 1947, and comprehensive planning began in 1963 when the third five year plan was started. The third plan was started in September 1962 with the goal to increase Gross National Product (GNP) by at least 6% annually. The plan was finished in March 1968 but the Gross National Product increased from 340.4 in 1962 to 556.4 billion of rials[1] in 1967, with a 10.3% average rate of growth.

The Gross National Product increased from 556.4 to 1168 billions of rials during the fourth plan which was from 1968 to 1973 for a 15.98% average rate of growth and 14% average rate of growth per capita.

The fifth plan was started in 1973 to 1978 which is not finished yet, but the Gross National Product was increased 49.42% in 1973 and 70.46% in 1974.

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[1] 70.50 rials = one U.S. dollar (as of October 1977).

During a 15 year time period from 1960 to 1975 the Gross National Product increased 10.48 times in current values or 5.75 times in constant values[2]. This means the average rate of growth during the same period was 16.9% and 12.3% respectively.

Fifteen years ago, Iran was among the 15 poorest nations of the world. Today it is among the 13 richest.

Iran had emerged from a low growth backward country to rank as a dynamic, progressive country with high growth. The story of economic development in Iran is of course unfinished. It eventually will have a happy ending, in that the country will join the rank of the world's richest and most advanced nations. In the arena of economic growth Iran is the front runner and it is expected to maintain this pace of development. Within 12 years Iran will become as developed as Western Europe is now. Thirteen years after that the country will rank among the five most advanced countries in the world.

B. PROBLEM ORIENTATION

A certain condition must exist to obtain such high rate of growth which is rare in the world. To keep continued economic growth and bring the country from developing to a developed country in a short period that is to join the rich and advanced nations, a lot of factors must be considered. A very careful program to coordinate social, economical and political development must be planned. The free market may not suffice. There is no doubt that the basic element for developing the society is economic position.

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[2] Base year is 1972.

Planned resources allocation is one strategy which must be considered, because this is the key to continued economic growth for Iran.

The resources must be used in those areas which give the maximum benefit in the shortest time. The resources must be allocated between private and public in order to give the maximum social benefit. When the free market is described it is a precondition that perfect certainty and perfect competition exist. The quantities supplied and demanded are all equal. In the long run all firms which can produce any product profitability will enter that industry. The equilibrium prices for all products and inputs are fixed. The market mechanism tends to yield an optimal allocation of resources. However, the perfect competition market does not exist in any society in the world. The optimal resource allocation is to allocate the resources where they receive the highest benefit. For the right investment decision, investments should be made in those projects which give the highest return, i.e., those that give the most social benefit that leads to economic growth.

The question which ultimately arises is which criteria in the absence of a free market determines the optimal resource allocation, i.e. when transferring resources from one sector to another? One may say the answers to these questions are the net present value criteria or rate of return. These tell one to invest in those projects which give the highest net present value or highest rate of return. The key to the net present value or rate of return criteria is the discount rate.

Under the perfect competition market, the discount rate is the same for all individuals in a society, but in reality where the market is imperfect, and in the uncertain world and where the risk premium

associated with each project is different and where the individual and collective choice may not be the same, then the discount rate for each project is different. The question then becomes what is the proper discount rate? The answer to this question is the subject of subsequent chapters.

Chapter 2 - The role of discount rate in the investment decision.

Chapter 3 - Public investment and the appropriate discount rate and its role in the economy.

Chapter 4 - Computing rate of return in Iran through the production function.

Chapter 5 - Conclusion.

II. <u>THE ROLE OF DISCOUNT RATE IN INVESTMENT DECISION</u>

The purpose of this chapter is to explain the role of the discount rate and its importance in investment and look into the concepts of present value; individual choich between saving, investment and consumption; real and money rates of interest; treatment of inflation in project evaluation; and the calculation of rate of return.

A. DEFINITION

It is necessary to introduce some terminology at the beginning of the chapter.

1. <u>Capital and Investment</u>

To the economist the term "capital" does not refer to quantities of money or their uses in purchasing stocks and bonds, rather it denotes "real" assets - factories, raw materials, machinery, inventories of finished and half-finished goods, etc. Capital in sum, is any previously produced input or asset of a business firm or any other producer.

Investment is a key concept in economics and is defined as the purchase of goods that will be employed in the production of future commodities or services. In other words it is defined as the purchase of capital.

2. <u>Discounted Rate of Return (ρ)</u>

The discounted rate of return on an investment is the interest rate earned on that investment over the course of its economic life, sometimes referred to as the effective yield of an investment, marginal rate of return, rate of return, marginal efficiency of investment.

operationally, the discounted rate of return is that interest rate which, when used to discount all cash flows pertinent to an investment, will equate the present value of the cash receipts to the present value of the cash outlays. In other words, it is that discount rate that will cause the net present value of an investment to be equal to zero.

B. INVESTMENT SAVING AND INTEREST RATE

The individual is the economic agent of the society. He wants to maximize his utility over his life time, but his utility is a function of current consumtion and furture consumption. To maximize his utility he may sacrifice some units of current consumption for future consumption through saving or investment or he may sacrifice some units of future consumption for current consumption through borrowing and disinvestment.

In this section it will be explained how an individual makes decisions to maximize his utility and what the role of the discount rate and the relationship is between discount rate and rate of interest and money rate of interest.

1. Saving and Consumption

For simplicity assume that there is a single consumption commodity X, and two time periods, denoting x_0 as the quantity of this year's consumption and x_1 as the quantity of next year's consumption.

In Figure 2.1 is an individual's preference maps (indifference curve U_0, U_1, U_2), assuming his endowment position is E, representing given quantities x_0 and x_1 of anticipated current and future income available to him before entering into exchange.

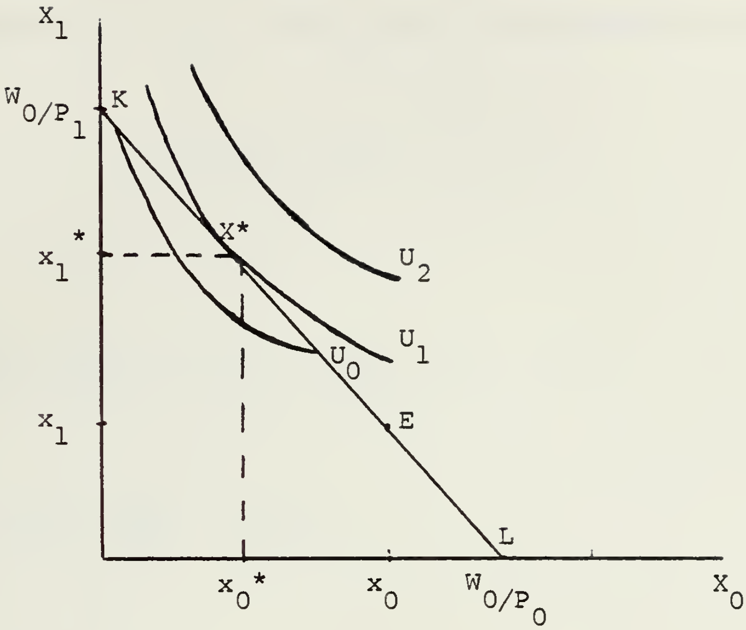


Figure 2.1

If W_0 is defined as endowed wealth the market value of his endowment of present and future claims, and P_0, P_1 as the market price of x_0 and x_1 (independent of quantity X), then endowed wealth W_0 limits his consumption choice over time and can be written:

$$W_0 = P_0\, x_0 + P_1\, x_1$$

$$x_1 = \frac{W_0}{P_1} - \frac{P_0}{P_1}\, x_0$$

$$\frac{\Delta x_1}{\Delta x_0} = \frac{P_0}{P_1} \qquad (2.1)$$

$\frac{P_0}{P_1}$ is greater than 1 because if 4 units of good x are exchanged this year for 5 units of good x in next year then $\frac{P_0}{P_1} = 1 + 0.25 = 1 + r$ where r is the market interest rate and $-(1+r)$ is the slope of budget line (KL).

The individual wants to maximize his utility over time subjected to his endowed wealth W_0. His utility function can be written as

$$U = F[U(x_0, x_1)]$$

Then

$$\text{MaxL} = F[U(x_0, x_1)] - \lambda(P_0x_0 + P_1x_1 - W_0)$$

$$\frac{dL}{dx_0} = \frac{dF}{dU} \cdot \frac{dU}{dx_0} - \lambda P_0 = 0$$

$$\frac{dL}{dx_1} = \frac{dF}{dU} \cdot \frac{dU}{dx_1} - \lambda P_1 = 0$$

$$\frac{dL}{d\lambda} = P_0x_0 + P_1x_1 - W_0 = 0$$

Write the first two conditions as

$$\frac{dF}{dU} \cdot \frac{dU}{dx_0} = \lambda P_0$$

$$\frac{dF}{dU} \cdot \frac{dU}{dx_1} = \lambda P_1$$

Divide the first by the second

$$\frac{dU}{dx_0} \div \frac{dU}{dx_1} = \frac{MUx_0}{MUx_1} = \frac{P_0}{P_1} = 1 + r \tag{2.2}$$

$\frac{MUx_0}{MUx_1}$ is the absolute value of the indifference curve slope. $\frac{P_0}{P_1}$ is the

absolute value of budget line slope. The optimum consumption is X* where the budget line is tangent to the indefference curve U_1. It follows that he consumes x_0* this year and saves (x_0 - x*) for next year. If his endowment position E is to the northwest of his optimum X* along the budget line then he would have borrowed some units of X this year.

2. <u>Saving-Investment</u>

As explained before the individual may transfer some units of current consumption for future consumption through investment. To maximize his utility he may invest some units of his current consumption for future consumption.

In Figure 2.2 again represent the budget line (KL) and prefrence map (indifference curve U_1, U_2, U_3) and endowment position E for the individual

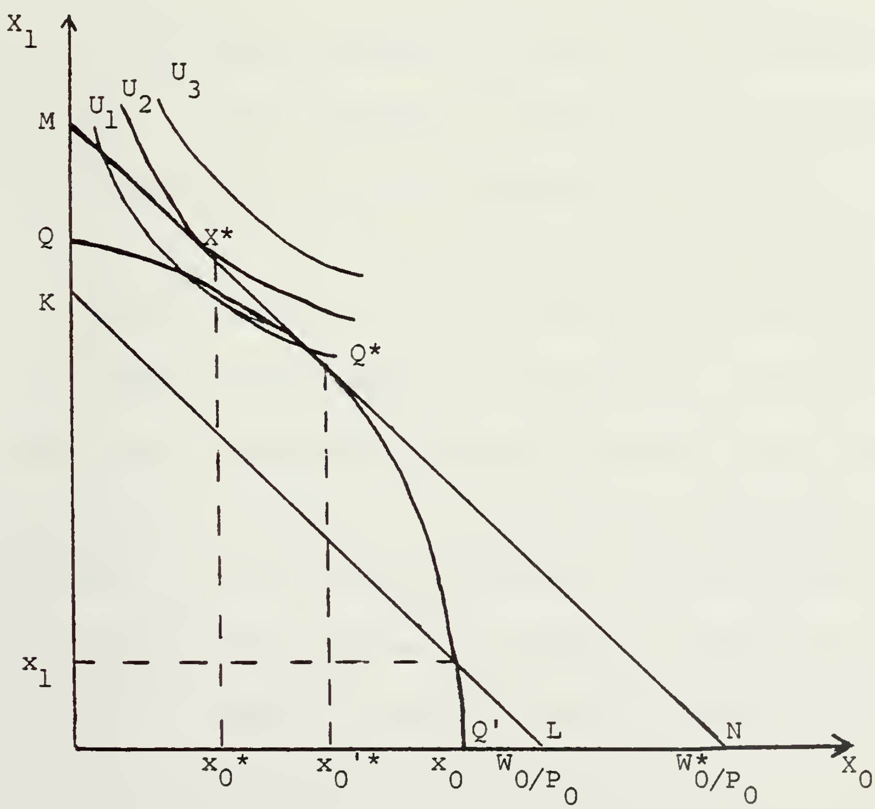


FIGURE 2.2

The QQ' curve is the production possiblity curve. If the individual invests one unit of x this year he will get x_1 unit or $(1+\rho)$ x unit back next year where ρ is the internal rate of return or discount rate.

$(1+\rho)$ is the absolute value of the production possibility curve slope. The concave shape of QQ' represents a kind of diminishing returns. For example, doubling the consumptive sacrifice (input) will not generally double the return (output of next year). It means ρ decreases as we invest more and more, $(1+r)$ as defined before is the absolute value of the budget line slope.

It is obviously superior for the individual here first to attain a productive optimum at Q*, where QQ' is tangent to the highest attainable budget line. This line MN is associated with the maximum attainable level of wealth W_0^*. It means he invests until

$$1 + \rho = 1 + r \quad \text{or} \quad r = \rho \tag{2.3}$$

As explained before the consumptive optimum is X* where the budget line MN' is tangent to the indifference curve U_2. The individual consumes x_0^* and saves $(x_0^* - x_0)$ and invests $(x_0 - x'^*)$.

Consider the Figure 2.2 if the X* is to the southeast of Q* along the budget line. He still invests $(x_0 - x'^*)$ but he would borrow some units of X to fully finance the investment. By imagining a different price P_1 (or interest rate r) determining different budget lines through each individual's endowment position E, the price expansion path can be obtained and these can then be translated into supply and demand curves for the separate individual, and for the market as a whole as in Figure 2.3. From the above argument we can conclude that under the perfect competition market the following result can be obtained.

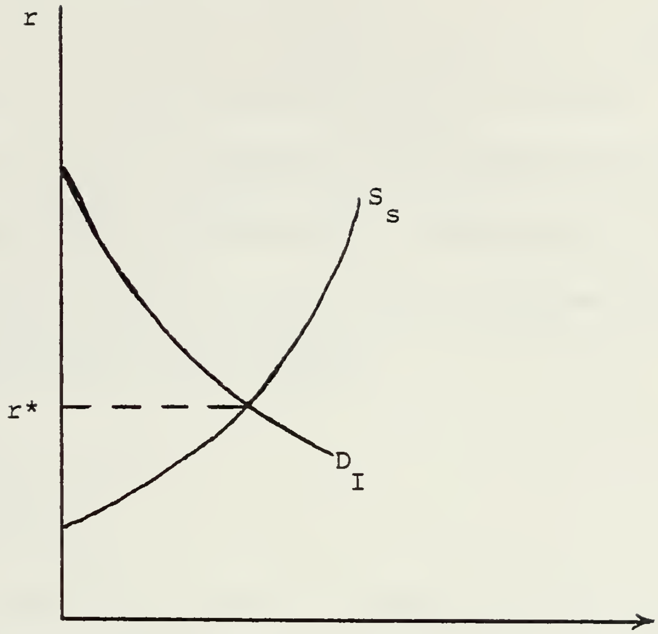


FIGURE 2.3

a. The interest rate is determined in the market and that is the equilibrium interest rate r* at which the aggregate supply of saving in the economy balances the aggregate demand for productive investment.

b. If there is only one interest rate for borrowing and saving then the economic agent of the society always invests until $r = \rho$.

c. The objective of investment in the private sector is to maximize his profit (utility): the objective of investment in the public sector is to maximize social welfare. Both sectors want to obtain the greatest benefit from investment. From equation (2.3), the discount rate or rate of return and interest rate will be equal in a society but in reality these rates will not be equal because of factors of uncertainty and risk associated with each investment and possibility of exchange with other societies.

3. Money Rate of Interest

The rate of interest referred to, so far in this chapter, is more specifically known as the real rate of interest.

The real rate of interest is the proportionate market premium on current real claims x_0 relative to real claim x_1 to be received one year in the future. Denoting quantities exchanged in market as Δx_0 and Δx_1 the exchange ratio must satisfy:

$$\frac{\Delta x_1}{\Delta x_0} = 1 + r$$

The rate of interest is ordinarily understood to be associated with the lending and borrowing of the money.

The money rate of interest is the premium on current money m_0 relative to the future money m_1 to be received one year in the future. That is, if current money is exchanged in the loan markets against future money in the amounts of Δm_0 and Δm_1, the exchange ratio defines the money rate of interest in the expression:

$$\frac{\Delta m_1}{\Delta m_0} = 1 + i$$

What is the relation between the real rate of interest r and the money rate of interest i? This is connected with movements of the "price level", that is with changes in price of the real good.

At time 0 and time 1 money is traded for real goods in exchange ratio $\frac{\Delta m_0}{\Delta x_0}$ and $\frac{\Delta m_1}{\Delta x_1}$. These exchange ratios define the current and future money price level P_0 and P_1:

$$P_0 = \frac{\Delta m_0}{\Delta x_0} \quad \text{and} \quad P_1 = \frac{\Delta m_1}{\Delta x_1}$$

These imply

$$(1 + i) \quad \frac{\Delta m_1}{\Delta m_0} = \frac{P_1(\Delta x_1)}{P_0(\Delta x_0)} = (1 + r) \frac{P_1}{P_0}$$

if we express the ratio of money price levels $\frac{P_1}{P_2}$ as $1 + a$, where a is the anticipated rate of price level inflation, then:

$$1 + i = (1 + r)(1 + a)$$

$$i = r + a + ar$$

When r and a remain in the usual range of persentage points the cross product term can to a fair approximation be ignored. Then

$$i = r + a \tag{2.4}$$

equation 2.4 shows that the money rate of interest equals the real rate of interest plus the anticipated rate of price inflation.

C. PRESENT VALUE

1. Future and Present Value

The concepts of future and present value focus on the time value of money, which is another name for interest. The time value of money refers to the fact that a dollar received today is worth more than a dollar to be received one year from today.

A dollar received today can be invested say at 10%, so that grows to $1.1 during the year. In contrast, a dollar to be received one year from today denies one the opportunity to earn the $0.10 interest for the year. In general the future value of $1 (after t period) is the amount to which $1 will increase at i interest rate for "t" period.

The present value of \$1 is the value now of a dollar to be received at some date in the future.

2. Discounting and Present Value

The process of converting a future cash flow to its present value by use of an interest rate is called discounting, and the resultant present value is frequently referred to as a discounted present value. Suppose that P dollar were invested for one year at a rate of interest i, compounded annually. Then at the end of the year it would yield $i \cdot P$ dollars in interest which, with the return of the principal P, would give us $P + iP = P(1 + i)$ dollars. Designate the initial sum as P_0 (P dollars at our initial date year 0) and the same at the end of one year as P_1 (meaning P_1 dollars receivable at the end of year 1). Then the expression is

$$P_1 = P_0 (1 + i)$$

That is, P_0 dollars now must be worth the same as $P_1 = P_0 (1 + i)$ dollars received at the end of the year. In other words

$$P_0 = \frac{1}{1 + i} P_1 = DP_1$$

where D is the fraction $^1/1 + i$. D is called the present value factor. DP_1 is called the discounted present value of P_1 dollars receivable one year from today. For example, if the rate of interest were 5 percent so that $i = 0.05$ then $D = {}^1/1{\cdot}05$ and \$ 1,000 receivable at the end of the year is today worth only $({}^1/1{\cdot}05)$ \$1,000 = \$ 952·38 (approximately), if the rate of interest were 10 percent then $D = {}^1/1{\cdot}1$ with the same conclusion $({}^1/1{\cdot}1)$ \$1,000 = \$ 909.091. It follows that the present value decreases as the rate of interest increases.

What is the present value P_0 of some amount, P_2 dollars to be received two years in the future? In one year P_0 will grow to $P_1 = (1 + i)P_0$, and in the second year this amount will increase again to $(1 + i)P_1 = (1 + i) \times (1 + i)P_0 = (1 + i)^2 P_0$. In other words, if P_0 is the correct present value of P_2 receivable in two years

$$P_2 = (1 + i)^2 P_0 \quad \text{or} \quad P_0 = \left(\frac{1}{1 + i}\right)^2 P_2 = D^2 P_2,$$

where D^2 represents the present vlaue factor for year two or in general D^n is called the present value factor for year n. Similarly, the discounted present value of P_n dollars receivable in n years is readily seen to be

$$P_0 = \left(\frac{1}{1 + i}\right)^n P_n = D^n P_n .$$

If the rate of interest were 10 percent then

$$D = \frac{1}{1 \cdot 1} \quad \text{and} \quad D^2 = \frac{1}{1 \cdot 21}$$

and \$1,000 is receivable at the end of one year is today worth only \$ 952.38 and \$ 1,000 receivable at the end of two years is today worth only $\left(\frac{1}{1 \cdot 21}\right)$ \$ 1,000 = \$ 826.446. It follows that the present value decrease as the number of years in the future in which the payment is to be received increases.

Figure 2.6 shows the relationship between present value factor (present value of \$1), interest rate, and time. More generally, suppose that a firm expects to receive R_0 dollars currently, R_1 dollars in one year, R_2 dollars in two years, etc. The total capitalized present value PV of this stream of expected receipts is given by

$$PV = R_0 + DR_1 + D^2 R_2 + D^3 R_3 + \ldots\ldots\ldots D^n R_n$$

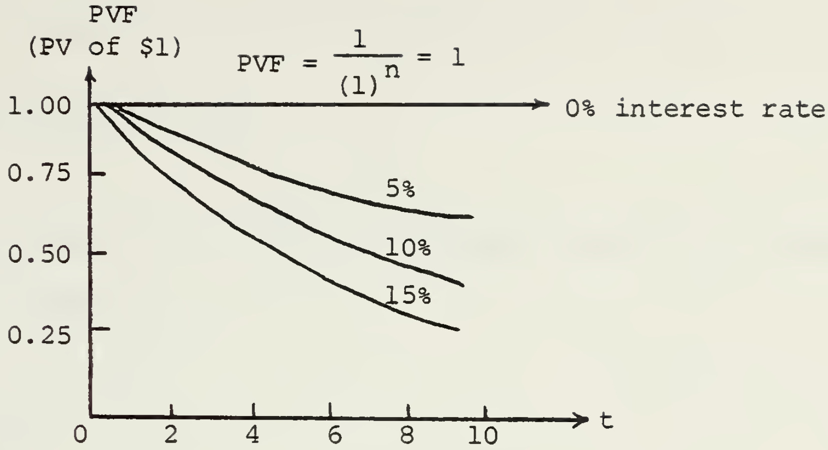


FIGURE 2.4

An important special case arises if all these expected receipts (or payments) are equal, i.e. if we have $R_0 = R_1 = R_2 = \ldots.R_n$

then

$$PV = R[1 + D + D^2 + \ldots.D^n]$$

multiplying and dividing by (1 - D)

$$PV = R[\frac{(1 + D + D^2 + \ldots.D^n)(1 - D)}{(1 - D)}]$$

$$PV = R[\frac{(1 + D + D^2 + \ldots.D^n) - (D + D^2 + D^3 + \ldots.D^{n+1})}{(1 - D)}$$

$$PV = R\ (\frac{1-D^{n+1}}{1 - D}]$$

In general when there are positive interest rates D^n grows smaller and smaller as n grows larger and larger and then D^n tends to disappear, i.e. it approaches zero as n approaches infinity. Then

$$PV = R\ (\frac{1}{1 - D}) = R + \frac{R}{i}$$

If receipt (or payment) in time -0 is equal to zero $R_0 = 0$, then

$$PV = R(\frac{1}{1 - D}) - R = \frac{R}{i}$$

In general the formual for computing the present value of a time-phased stream of future amounts is:

$$PV = \sum_{t=0}^{N} \frac{R_t}{(1 + i)^t} \tag{2.5}$$

where PV is present value, R_t is the amount of the revenue (or cost) in the t^{th} year (or period), i is the interest rate (in this case assumed to be the same for all years), N is the total number of years (or period).

3. Net Present Value (NPV)

The net present value is the difference between present value of the cash receipts (reveneu) and the present value of the cash outlay (cost) directly traceable to the investment. The formual for computing net present value (NPV) is:

$$NPV = \sum_{t=0}^{N} \frac{R_t - C_t}{(1 + i)^t} \tag{2.6}$$

where R_t is the amount of the revenue in the t^{th} year (or period), C_t is the amount of the cost in the t^{th} year (or period), i is the rate of interest, N is the total number of years.

Example: Suppose investment in a project is made and the revenue and cost are:

Year	Cost	Revenue
0	$1,000	$ 0
1	200	400
2	100	600
3	0	600

If the interest rate is 10 percent then:

$$\text{PV of Cost} = 1000 + \frac{200}{1\cdot 1} + \frac{100}{(1\cdot 1)^2} + 0 = \$\ 1{,}264.463$$

$$\text{PV of Revenue} = 0 + \frac{400}{1\cdot 1} + \frac{600}{(1\cdot 1)^2} + \frac{600}{(1\cdot 1)^3} = \$\ 1{,}310.293$$

The net present value is (1310.293 - 1264.463) = \$ 45.83 using the equation 2.6 then

$$NPV = \frac{-1000}{(1\cdot 1)^0} + \frac{400-200}{(1\cdot 1)} + \frac{600-100}{(1\cdot 1)^2} + \frac{600-0}{(1\cdot 1)^3} = \$\ 45.83$$

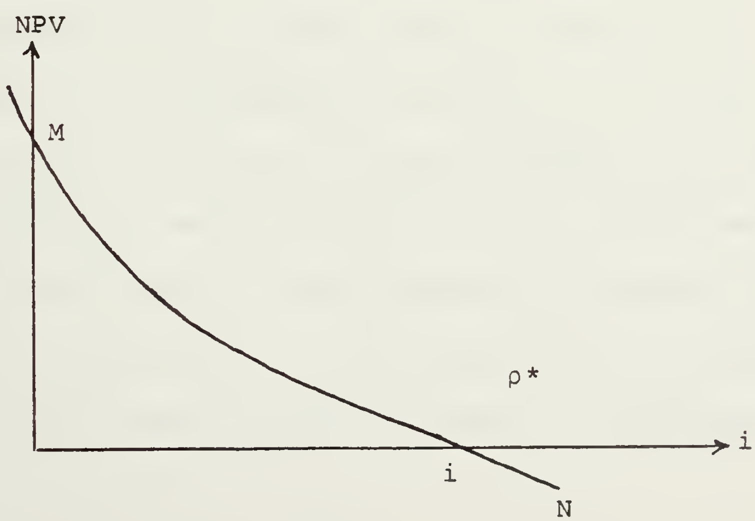
D. CALCULATING DISCOUNT RATE

As defined before discount rate or rate of return is that discount rate that will cause the net present value of an investment to be equal to zero. Mathematically the formula used to calculate the rate of return is:

$$NPV = \sum_{t=0}^{N} \frac{(R_t - C_t)}{(1 + \rho)^t} = 0 \qquad 2.7$$

where ρ is the rate of return.

Figure 2.7 shows where $i = \rho$, the NPV = 0. To calculate ρ, put different values for i in the formula.



For example i = 0, 5, 10, 15, 20 percent. Then estimate the shape of the graph and ρ, put the estimate ρ in the formula. If NPV > 0 put $\rho + \varepsilon$, if NPV < 0 put $\rho - \varepsilon$. Repeat until ρ^* that makes NPV = 0.

Example: Suppose in the project that revenue and cost are:

Year	Revenue	Cost
0	$ 0	$1400
1	800	250
2	750	145
3	600	67.6

$$\sum_{t=0}^{3} \frac{R_t - C_t}{(1 + \rho)^t} = 0 = -1400 + \frac{550}{1 + \rho} + \frac{605}{(1 + \rho)^2} + \frac{532.4}{(1 + \rho)^3}$$

ρ = 8% $\rightarrow$ NPV = $ 50.58

ρ = 12% $\rightarrow$ NPV = -47.67

ρ = 10% $\rightarrow$ NPV = 0

The rate of return or discount rate for this project is 10 percent.

E. INVESTMENT IN PRIVATE SECTOR

1. Investment Decision

As discussed before the market serves to coordinate choices between consumption now and consumption later because production opportunities tend to make possible greater consumption in a later period in exchange for an amount sacrificed in the current period.

The price that serves to coordinate choices between present and future is the interest rate. Under certainty and in the absence of market imperfections, everyone is fully informed of the current and

relevent future states of the economic world. Everyone knows the income streams associated with any given investment, and there is a unique rate of interest at which everyone can borrow and lend to finance the selected investment. Since there is no room for risk of default or uncertainty in future income streams, there are no premiums paid for risk bearing above the market clearing rate of interest. In this situation the firm will be motivated to invest in its own activities until its marginal rate of return is exactly equal to the market interest rate. This is so because if it had not yet reached that point, the firm could borrow money at the market interest rate, invest it within the firm, and return more in the following period than would be needed to repay the loan. In reality the interest rate for borrowing and lending is not the same. The decision to invest in new projects depends on whether the expected rate of return on the project is greater than the cost of borrowing the necessary funds or, if the funds are already available, the cost of the earnings lost by spending on the project rather than by lending out the funds.

But what is the expected rate of return on a project? That is the rate of interest that makes the discounted value of all expected future earnings exactly equal to the cost of the project? If this rate is ρ and is the same as the rate at which money can be borrowed, then it is a matter of indifference whether funds are used to spend on the project or to lend at interest i. On the other hand, if $\rho > i$ the present value of the future earnings of the project is greater than the present value of a bond, so that it will be more profitable to invest in the project than to lend funds to someone else.

2. Investment Decision Rules

Usually there are two rules for investment decision making.

a. Net Present Value Rules

Net present value rule # 1: Adopt any incremental project for which net present value is positive; reject any project for which net present value is negative (note that this rule has the same form for investment and disinvestment projects).

Net present value rule # 2: If two projects or combinations of projects are mutually exclusive, adopt that which has the higher net present value.

b. Internal-Rate Rules

1 = ρ, i comparison rule: Adopt any project for which internal rate of return ρ is greater than the interest rate i.

2 = ρ - maximization rules: If two projects are mutually enclusive, adopt that which has the higher internal rate of return in other words, the higher the internal rate of return, the better the project.

c. Evaluation of Methods

The net present value method tends to make investments of large amounts appear relatively attractive because it expresses profitability in absolute dollar amounts. Thus, unless all investments are of equivalent size, the net present value cannot be relied upon for ranking purposes. The discounted rate of return is a relative measure and is not affected by the size of the investment. Thus, it tends to produce accurate rankings. It is possible that the discounted rate of return will not produce the same ranking because the discount rate used in the net present value method is the firm's cost of capital. The discount rate used in computing the discounted rate of return is that rate of return itself. The two methods entail the implicit

assumption that cash receipts from an investment are immediately reinvested in some project to yield a rate of return equal to the discount rate used in the basic analysis.

Management might decide that the best implicit assumption is that the rate of return available on current investments will also be available in the future. Alternatively, management might prefer the more conservative assumption that cash receipts can be reinvested to earn no more than the cost of capital. Whichever method is chosen, its implicit reinvestment assumption should be recognized.

The fundamental difficulty is when ρ may not be unique. In a simple situation the net cash flow is negative only at present, the time of the initial outlay. Subsequently, the net cash flow is consistently positive. In this case the algebraic sign of the successive net cash flow over time changes only once. If the sign of the net cash flows in successive period changes more than once, there may be as many rates of return as there are sign changes. Consider, for a project with changes.

Years	Cost	Benefit
t = 0	2	0
1	0	10
2	12	0

let ρ = 2 then

$$\sum_{t=0}^{2} \frac{R_t - C_t}{(3)^t} = -2 + \frac{10}{3} - \frac{12}{9} = 0$$

let ρ = 1 then

$$\sum_{t=0}^{2} \frac{R_t - C_t}{(2)^t} = -2 + \frac{10}{2} - \frac{12}{4} = 0$$

both $\rho = 1$ and $\rho = 2$ is the internal rate of return for this project.

As a matter of fact, if an adequate analysis of the multiple rates of return is made, one of them may be identified as the relevent one for purposes of investment decision making. Fortunately, the majority of business investment proposals fit into the simpler case that produces a single, determinate discount rate of return.

F. TREATMENT OF INFLATION

Inflation must be considered in project evaluation. Two present methods can be used to calculate project's cost or benefit adjusted for inflation. Consider an example to introduce the two methods.

Assume that a project will produce ten units of good X next year when the current price of X is \$ 10, money rate of interest is 10 percent, and inflation rate is 5 percent. The revenue next year is \$100 (constant dollars), or \$ 105 (current dollars). What is the present value of next year's revenue? The two methods that can be used are:

1. Inflate the cost or benefit first then introduce the discount rate, for example:

$$100\ (1 + a) = 100\ (1\ .05) = 105$$

$$105 \div (1 + i) = 105 \div 1.1 = \frac{105}{1.1}$$

2. Discount the cost or benefit first then introduce the inflation, for example:

$$100 \div (1 + i) = 100 \div 1.1 = \frac{100}{1.1}$$

$$\frac{100}{1.1}(1 + a) = \frac{100(1 + .05)}{1.1} = \frac{105}{1.1}$$

In fact both methods give the same result. In general; when working with constant dollars discount with real interest rate

$$i = r + a + ar$$

$$r = \frac{i - a}{1 + a} = \frac{0.05}{1.05} = \frac{5}{105}$$

then

$$100 \div (1 + r) = 100 \div (1 + \frac{5}{105}) = \frac{105}{1.1}$$

when working with current dollar discount with nominal rate of interest

$$105 \div (1 + i) = \frac{105}{1.1}$$

gives the same result.

G. SUMMARY

In the perfect competition market discount rate, internal rate and market interest rate are the same but in reality there is no perfect competition in any society, but in any case the discount rate is the key which determines the current and future consumption. In other words the discount rate determines how much should be invested or saved for future consumption.

The two criterion for investment decision are net present value rules or internal rate of return rules. Which of these rules is preferred depends on the assumptions made by management.

If it is assumed that the rate of return available on current investments will also be available in the future, then the rate of return is preferable. On the other hand, if management assumes that the cash receipts can be reinvested to earn no more than the cost of capital, then the net present value rule is the correct one.

III. PUBLIC INVESTMENT AND THE APPROPRIATE DISCOUNT RATE

The goal of all government action of course is to improve national welfare, so the objective of public investment is not only to gain more capital but rather to distribute the most benefit to the society. This requires allocation of resources which gives the most benefit. The discount rate is the key which indicates correctly where the resources must be used. This chapter shows that, not only does the discount rate determine how the overall level of investment should be divided between private and public sector, but also given the level of investment in the public sector, how it should be allocated among project.

A. METHODS OF RANKING PROJECT

For public investment decision, a rule similar to that of the private sector should be used. For example; internal rate of return rules or net percent value rules.

In the private sector the discount rate used to calculate the net precent value is the cost of capital or comparing the internal rate of return with cost of capital.

But the government must determine the discount rate which is appropriate for the projects evaluation by the government.

The choice on appropriate social discount rate is discussed in subsequent section of this chapter. For now it is sufficient to view it as the opportunity cost of using funds for government projects. Here it is shown that ranking projects by their internal rate of return is favored.

Consider the Figure 3.1 which represents the relationship of net percent value and internal rate of return.

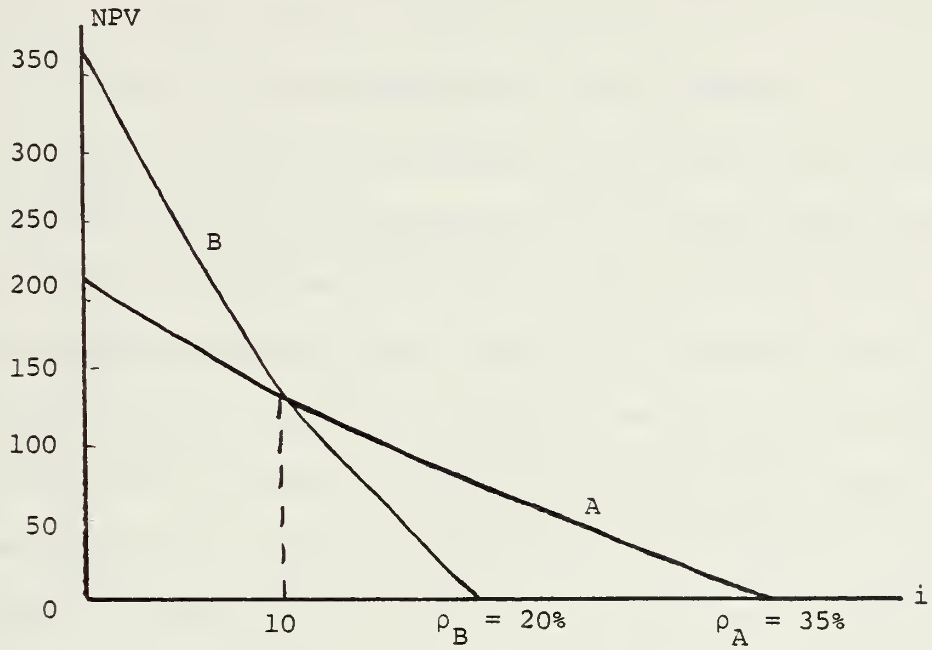


FIGURE 3.1

The diagram has net percent value on the vertical axis and the rate of interest used in calcualting them on the horizontal axis.

In most instances the net percent value rules and the internal rate of return rules lead to the same result if the same rate of discount is used for each. The internal rate of return rule is preferred because it does not require recalculation every time that the rate of discount changes. As explained in chapter two as the discount rate changes, the net percent value also changes, so the discount rate chosen affects the ranking of projects by the present value criteria. For example, if 5 percent is chosen as the rate of interest for present value calculations in Figure 3.1, then project B would have priority over investment A, on the other hand if 12 percent is chosen as the rate of interest, then project A would have priority over project B. This switching of priorities

would not have been a problem if A and B had had similar time horizons because their net present value function would have been more or less paralle. Nor would there be any problem if internal rates of return had been used to select project A with 35 percent first and then project B with 20 percent, if this exceeded the rate of discount.

The internal rate of return rules do not depend on an interest rate being selected and if it is assumed that the future opportunity will resemble current ones then the internal rate of return rules are more appropriate than the net present value rules especially when the projects with widely different sizes or different time horizons are compared.

The solution to multiple value of internal rate of return is that one may simply graph the net present value as in Figure 3.1 and select the highest internal rate of return at which the net present value function is zero and also has negative slope.

Another advantage of internal rate of return rules is, if the calculations are made in real terms, i.e., projecting prices observed at the time of analysis into the future. The internal rate of return will not have to be recalculated for all the "shelved" projects every time real interest rates change.

B. DETERMINATION OF APPROPRIATE DISCOUNT RATE

As noted, the criterion or comparision of projects is the net present value rules or internal rate of return rules. The appropriate discount rate in these criteria is the opportunity forgone in the private sector for using capital in the public sector.

The internal rate of return in the private sector is the opportunity cost of capital in the public sector. A number of economists have

argued that this rate must be adjusted for other factors which is discussed later on in this chapter. First determine the opportunity cost of government investment.

C. OPPORTUNITY COST OF CAPITAL

The opportunity cost of government's expenditure of capital is used in the private sector for consumption or investment. In the private sector the marginal rate of time preference for consumption is equal to the marginal rate of investment because the present value of utility of future returns from marginal investment must be equal to the utility of consumption currently forgone. Therefore it is necessary only to determine one of the rates in order to estimate the opportunity cost of capital used to finance government projects. Under certainty, and in the absence of market imperfection where there is a unique rate of interest which everyone can borrow and lend, the selected investment or to pay for consumption, then the opportunity cost of capital is the market interest rate. But there is no such case in any society. In reality the rate of interest for borrowing is different from the rate of interest for lending. For example the saving deposits may earn 5 to 8 percent while the rate paid for purchasing of goods from department stores for on an installment basis may be 15 percent or more. There are many other individuals for whom the time preference rate are highly problematical and uncertain, like those that hold cash, stamps, painting, etc.

Because of the diversity of cases and the lack of precision with which time preference rates can be ascertained for even the single individual, it is preferable to use the investment rate of return as the indicator of government expenditure opportunity cost. The investment

rate of return would be one to be used as the opportunity cost of government expenditure were it not for a number of additional factors.

D. TAX AND OPPORTUNITY COST OF CAPITAL

The rate of return on investment in the private sector must be adjusted for taxes which are a deduction from private but not government returns from investment. This adjustment may be made by multiplying the rate of return on investment in private by the reciprocal of unity minus the marginal tax rate, or

$$\rho' = \frac{\rho}{1 - \alpha}$$

where ρ' is the rate adjusted for taxes ρ is rate of return on investment in private sector and α is the marginal tax rate on income. For example if the firm's rate of return is 10 percent (after tax) and the firm's marginal tax rate is 50 percent then the opportunity cost of capital for this firm is

$$\rho' = \frac{10}{1 - .5} = 20\%$$

as noted the rate of return is different from producer to producer. Even the tax rate is not the same for all producer. Let us turn now to the other problem. Assume the private individual who produces certain items for his own use which pays no taxes on his production process. Assume also that there are available for sale government bonds offering a rate of return of say 6 percent then what is the opportunity cost of resources withdrawn from him? Since goods produced by himself for his own use do not provide a rate of return that is measurable directly. It is necessary to find some indirect means by which his opportunity

cost can inferred. If his investment in his own production were worth more than 6 percent to him he would not buy the bond.

If his investment in his own work were worth less than 6 percent to him he would purchase more bonds. Therefore, without any conscious calculation on his part, a consumer's security purchases reveal something about what the rate of return of investment in the production of goods for his own consumption is worth to him. The opportunity cost incurred when a dollar's worth of resources is prevented from going to him and is transferred to a government investment project.

E. THE ROLE OF TAXES IN CALCULATION OF THE SOCIAL DISCOUNT RATE

The previous section presented two examples which determined the opportunity cost of government investment when the resources were withdrawn from one sector of the economy. But government may take the resources from different sectors with each sector having different opportunity costs. Then what should be done in this case to calculate a single discount rate for the evaluation of government project? In general the correct discount rate for a project will be a weighted average of the opportunity cost rate for the various sectors from which the project would draw its resources, and the weight for each such sector in this average is the proportion of the total resources that would come from that sector. The following two examples shows how to calculate discount rate.

1. Suppose the government requires $ 10,000 to finance a new project and this amount has been taken from three different sectors. The opportunity cost rate for the resources and the proportion of the total investment from each sector are as follows.

Sector	Amount	Percentage of Total Resources	Opportunity Cost Rate
A	3000	30	15%
B	4000	20	20%
C	5000	50	10%

Then the social discount rate can be calculated as follows:

$$0.3 \times 0.15 + 0.2 \times 0.2 + 0.5 \times 0.1 = 13.5\%$$

2. Suppose the opportunity cost rate for the three sectors were the figures in our previous illustration (15, 20 and 10 percent). And suppose the resources to be employed in the proposed project would otherwise have been divided into the following proportion:

	Percent
A	10
B	15
C	15

Then the social discount rate would be

$$0.7 \times 0.15 + 0.2 \times 0.15 + 0.1 \times 0.15 = 15\%$$

F. RISK AND THE SOCIAL DISCOUNT RATE

A number of economist have argued that the risk for investment in an individual project taken by itself does not necessarily correspond to the risk it contributes to society's investment as a whole. Therefore the social discount rate must be different from the private discount rate. For this reason the following three approaches are presented based on the arguments of S. A. Marglin, Kenneth J. Arrow, Charles J. Hitch and Roland N. McKean.

1. Arrow Approach

Risks typically vary from industry to industry and from firm to firm. A risky industry may be expected to offer comparatively high profit prospects in order to be attractive to investor. That is why the returns on corporate bonds is normally higher than that on a comparable government security because there are risk premiums associated with corporate bonds, where investment on government security is not risky.

It follows that the rate of return the government should require should vary from one project to another, according to its riskiness. This view hinges on the assumption that the government, like private individuals should display risk aversion in its behavior. But Kenneth Arrow has argued that, because government risks are spread over so many more projects than those of firms in the private sector, the overall protfolio is essentially risk free. More important, because in the economy a very large number of projects are underway at any given time, the insurance principle, that is, the statistical "law" of large numbers applies to them. That is the larger the number of projects involved the smaller the risk contributed to total society returned by any one of them, taken as a whole. From the viewpoint of society they become virtually riskless. This is essentially the pricicple on which a life insurance company operates. It cannot tell when any one of its policy-holders will expire and, taken by itself, the risk of insuring him is enormous. But when it insures a large body of policy holders the operation becomes virtually riskless.

It can be concluded that the social discount rate is equal to the social opportunity cost and it is lower than the rate of return in the private sector.

2. Hitch and McKean Approach

The Hitch and McKean approach basically deals with the projects of military system investments in which high risk will be involved with longer lead time in the future. In military investments, since benefits cannot be measured in dollars, and since it is not an economic decision to evaluate the trade offs among different kinds or even time patterns of social benefits, the marginal productivity of investment is meaningless for evaluating military investment. It can be said, given the objectives, the problem is to seek the least-costly manner of achieving them.

Hitch and McKean have argued that in comparisions of alternative military system. The cost and benefit must be discounted the same as they are in the private economy, because of $ 150 cost (or gain) that will occur ten years hence is the equivalent of only, say $100 now. The more important reason for discounting future cost and benefit namely, the existence of risk and uncertainty about the gain and cost. The war for which we are preparing may occur before the date at which the cost would be incurred. Peace may break out or disarmament be achieved. We live in an uncertain world, and it military aspects are more plagued by uncertainty then most other. Military technology is passing through a revolution. Future weapon capabilities that look attractive today may be useless tomorrow. But what rate should be used in comparisons of alternative military system? Hitch and McKean state that the marked interest rate is the minimum rate appropriate in comparing military systems but to add an appropriate risk premium to this minimum rate. It should be allowed to some extent for the chances that the future benefits expected may never be realized, that the costs may not have to be incurred, and that the estimated amounts may turn out to be wrong.

But it cannot be hoped to learn precisely how risky any particular military investment is. Some investments are certainly more risky than others.

Perhaps an appropriate discount rate for military investment would be a rough average rate of return in the private economy. This rate would include an average allowance for risk while the appropriate rate for an advanced weapon system might be higher. Special degrees of risk associated with particular weapon systems should be pointed out by the analyst but would have to be allowed for subjectively by the final decision-maker.

3. Marglin Approach

S. A. Marglin attempts to show that the social rate of discount should differ from the interest rate ruling in the competitive market, and that the appropriate rate of discount for all investment, public or private, is the social rate, not the market rate. It follows that not only should a government disregard the market rate of interest in planning public projects but it should bring about a socially optimal level of investment by direct investment and by pursuing policies designed to influence the level of private investment.

He states that the appropriate discount rate is lower than the marginal rate of return on private investment, because an individual might be willing to make a gift to one of his fellows if he knew that others were doing so even if he would not make the gift on his own. Individuals who would not be willing as individuals, to contribute to various cases may be willing as participants in a group to make such contribution. Each may consider the sum of his own sacrifice and the sacrifice of others as less important than the gain derived from the

joint gift. Society may be willing to make larger sacrifices of our personal consumption (or saving) to increase the incomes of our fellow man collectively than individually the preference of men acting in market are inconsistent with the preference of these men when they come to the ballot box. Thus a man may not invest individually for future generation, but may vote for such an investment to be made collectively.

Marglin pointed out that society seems to be at an impasse: nobody wants to invest himself though each would like to see other investment. But not all of us like to see other investment, each would be willing to invest himself provided others did so, for in this case the psychic gain from others' investment would out weigh the loss on one's own investment. That is, none of us is willing to invest unilaterally, but each of us is prepared to if all do.

Over all he argued that the appropriate discount rate for govenment projects evaluation is much lower than the marginal rate of return on private investment because society as a whole prefers to make greater provision for future generation than would be indicated by individual time preference rates.

G. THE ROLE OF DISCOUNT RATE IN ECONOMY

The acceptable discount rate is no less than the allocation of resources between private and public sectors of the economy. Using an improper discount rate means using resources inefficiently. In other words, using improper discount rate may accept the project that should be rejected or reject the project that should be accepted. For example if the correct social rate of discount is 10 percent but government uses 8 percent as a discount rate for project evaluation, then the

government will accept the project which gives the nine percent rate of return. But in fact social cost exceeds the benefits because if the resources are used by the private sector then the rate of return would be 10 percent. In contrast if the government uses 12 percent as a discount rate it may reject the project which gives the rate of return 11 percent and the resources remained in private sector which gives 10 percent rate of returns. Using proper discount rate means the best alternative use of the resources. This lead to maximum benefit to society.

Given the proper discount rate then society can allocate the over all level of investment between the private and public sector. For example: assuming the social rate of discount is ρ^*. If the government used ρ^* as the discount rate for project evaluation then:

$$NPV = \sum_{t=0}^{N} R_t/(1 + \rho^*)^t - C_t/(1 + \rho^*)^t$$

if NPV is greater than zero then taking resources from private sector to invest in this project gives more benefit to society. In fact the social discount rate determines the cut off point for the level of investment in public sector.

It can be concluded that the role of the discount rate is important in the economy because it not only determines how to allocate the resources between public and private sector but also how it should be allocated among projects which lead to optimal resource allocation and economic growth.

H. SUMMARY

The government agencies can rank projects on the basis of a single criterion. The internal rate of return and choose those projects with the highest internal rates of return first staying above the social discount rate. Where the multiple value of internal rate of return are possible select the highest internal rate of return at which the present value function is zero and also has a negative slope.

The appropriate discount rate for the evaluation of government projects is the opportunity foregone in the private sector for using resources in the public sector. That is the percentage rate of return that the resources would otherwise provide in the private sector.

When a public activity draws resources from a number of sectors in the economy, the correct discount rate will be a weighted average of the opportunity cost rate for the various sectors from which the project would draw its resources.

Some economists have argued that the social discount rate or the correct discount rate for the evaluation of government projects must be different from the private. Kenneth Arrow has argued that because government risks are spread over so many more projects than those of firms in the private sector, the overall portfolio is essentially risk free and therefore that marginal risk of any single project risks be ignored in calculating the appropriate discount rate. It means that the social discount rate must be lower than the rate of return in private sector. Stephen Marglin states that the appropriate discount rate is much lower than the marginal rate of return on private investment because society as a whole prefers to make greater provision for future generations than would be indicated by the individual time preference rate. On the

other hand Hitch and McKean states that for government where advanced weapons systems investment are affected by the international situation, the discount rate used must be higher than the marginal rate of return in private investment.

These three economist argue that a factor must be added or subtracted from the private rate of return. The amount of this factor is hard to measure. For this reason the opportunity cost rate may be used as the social discount rate.

The role of discount rate is important in the economy, because it is the key for allocation of resources between private and public sector. The right discount rate becomes that number which indicates correctly when resources should be transferred from one sector to another.

IV. COMPUTING RATE OF RETURN IN IRAN

The last chapters have presented the role of the discount rate in the economy which indicate exactly when the resources must be transferred from one sector to another.

It was also shown that the formula for the evaluation of the social discount rate is the weighted average of the rate of return in the various productive sectors from which resource would be withdrawn for the government project under consideration. However, it is not easy to determine in practice from what productive sector a given project will be drawn. The government may use a single discount which is dependent on the system of taxation and the rate of return in the private sector. Another problem for determining the social discount rate is to compute the rate of return figure for the various sectors of the economy which is the key to determine the social discount rate. If the production function for various sectors of the economy is known, then to compute the rate of return is not difficult.

A. METHOD OF MEASURING PRODUCTION FUNCTION

There are three methods which are used to determine the production function. One of these three methods which is used in this presentation is based on the statistical analysis of time series data concerning the amount of various inputs used in various periods in the past and the amount of output produced in each period. For example data concerning the amount of labor, and the amount of capital in various sectors during each year from say 1960 to 1975, can be used. On the basis of such data and information concerning the annual output in each sector during the

same period, it can be estimated what the relationship between the amounts of input is and the resulting output. The estimate of the production function is based on the assumption that the production faction is the so-called Goble-Douglas function which is:

$$Q = A\, K^{\alpha}\, L^{\beta}\, M^{\delta}$$

Where Q is the output rate: K is the quantity of capital, L is the quantity of labor, M is the quantity of raw materials and A, α, β, and δ are parameters that vary from case to case.

In this presentation only two factors, production labor (L) and capital (K), are considered. Since the output is gross national product (Q) and it is a value added concept, intermediate factors of production cancel out. Then the formula we use to estimate production function in each sector of economy is

$$Q = A\, K^{\alpha}\, L^{\beta} \qquad (4.1)$$

The industrial, services and agriculture sector in Iran were chosen to estimate their production function and rate of return by using their historical data on labor, capital, and output.

B. SOURCE OF DATA

The gross national product, gross domestic fixed capital formation and employed persons by industrial, services and agriculture sector used in this chapter are presented in Tables 1, 2, and 3 in the Appendix which are all taken from "Bank Markarzi Iran annual report and Balance Sheet" which was published by Bank Markarzi Iran in 1973 and 1975, and from the statistical data book which was published by Iran Statistics Center in 1976.

C. COMPUTING THE CAPITAL STOCK

To estimate the production function and compute the rate of return for the industrial, services and agriculture sectors as formula 4.1 shows, the capital stock for each year is necessary. This is not given the gross domestic fixed capital formation or the investment increment to capital stock are given for each year which is tabulated in Table 2 in the Appendix.

1. Method of Computation

The accelerator technique was used to find out the relation between capital stock and output. This method says some constant a plus a change between any two time periods times some constant b, equals the amount of investment I. It can be written as follows:

$$a + b\ (Q_t - Q_t) = (K_t - K_{t-1}) = I_t$$

where the Q is output, K is the capital, I is the increment to capital stock and t stands for the time period.

To compute the intercept a and slope b it is necessary to find out the change of output $(Q_t - Q_{t-1})$. The change of output in the industrial, services and agriculture sectors, from 1965 to 1969 were computed. The result of computation with the change of capital stock which is $(K_t - K_{t-1})$ are tabulated as Table 4, 5, and 6 in the Appendix.

2. The Intercept and Slope of the Regression Line

In order to compute the intercept a and slope b, regression analysis must be done with two variables, the change of output and capital.

The intercept, slope and standard error for both of them must be derived. The problem can be solved by computer or can be derived by the following formula:

$$b = \frac{\Sigma q_t I_t - n\bar{q}\bar{I}}{\Sigma q_t^2 - n\bar{q}^2}$$

$$a = \bar{I} - b\bar{q}$$

$$S_d^2 = \frac{\Sigma I_t^2 - n\bar{I}^2 - \dfrac{(\Sigma q_t I_t - n\bar{q}\bar{I})^2}{\Sigma q_t^2 - n\bar{q}^2}}{n-2}$$

$$S_b^2 = \frac{S_d^2}{\Sigma q_t^2 - n\bar{q}^2}$$

$$S_d^2 = \frac{S_d^2}{n} + \bar{q}^2 \cdot S_b^2$$

wher the q is the change in output, $\bar{q}$ is the average change in output, I is change in capital stock, $\bar{I}$ is average change in capital stock, n is the number of period, t stands for time period, S_b is the standard error of the slope and S_a is the standard error of the intercept. The problem was solved by the computer and the results are as follows:

Results / Sectors	Intercept (a)	Slope (b)	Standard Errors	
			S_a	S_b
Industrial	27.68265	1.772346	13.30636326	0.24476
Services	29.97487	0.6537506	6.4649063	0.06499
Agriculture	3.370967	0.701289	1.084873242	0.03972

3. Level of Confidence

The slope and intercept were computed. But before using them to find out the capital stock, a significan test, to know what was the level of confidence, must be computed. The ratio of intercept over standard error of intercept and slope over standard error of the slope indicates the level of confidence to find the ratio. The normal distribution table can be used if the sample size n is greater than 30. For n below 30 the t distribution is used with n - 2 degrees of freedom.

In this problem the t distribution was used, because n is equal to ten. The result of testing are as follows:

Sector \ Test	$\frac{\text{Slope}}{\text{Standard Error}} = \frac{b}{S_b}$	Minimum Level of Confidence	$\frac{\text{Intercept}}{\text{Standard Error}} = \frac{a}{S_a}$	Minimum Level of Confidence
Industrial	$\frac{1.772346}{0.24476} = 7.24$	99%	$\frac{27.68265}{13.306363} = 2.08$	92%
Services	$\frac{0.6537506}{0.06499} = 10.05$	99%	$\frac{29.97487}{6.4649} = 4.64$	99%
Agriculture	$\frac{0.701289}{0.03972} = 17.65$	99%	$\frac{3.3709067}{1.084873242} = 3.107$	98%

a and b can be used to compute the capital stock for the industrial, services and agriculture sector.

4. Computing the Capital Stock

a and b from the regression analysis can be used to compute the capital stock for each year in the three sectors as follows:

a. Initial year: to compute the capital stock for initial year in industrial, services and agriculture we know that

$$K_t = a + bQ$$

This formula is used to compute the capital stock for the initial year (for year 1965).

b. Remaining years: The amount of investment for each year is I_t, this amount can be added to the capital stock to compute the following period's time capital stock. The formula is:

$$K_t = K_{t-1} + I_t$$

The capital stock (industrial, services and agriculture) for each year are computed and listed as table 7, 8, and 9 in the Appendix.

D. MEASUREMENT OF PRODUCTION FUNCTION

The method used to estimate production function, was the Cobb-Douglas function which is

$$Q = A K^{\alpha} L^{\beta}$$

This function can be rewritten as a linear form, the natural logarithm of output equals to natural log constant A plus α times natural log capital, plus β times natural log labor the formula can be written as:

$$\ln Q = \ln A + \alpha \ln K + \beta \ln L \qquad (4.2)$$

Capital, output and labor for each year can be used to compute α, β and A.

1. Regression Analysis

In order to estimate production function α, β and A must be computed. The method to compute them from the formula 4.2 is to do regression analysis with three variable (lnQ, lnK and lnL). The first problem is to compute lnQ, lnK and lnL with the same year for industrial, services and agriculture, which was done and the results are presented in tables 10, 11 and 12 in the Appendix.

2. <u>How to Find α, β, A and Standard Errors</u>

It is hard to solve the problem by hand, but an easy and more correct way is to do the regression analysis by computer. This problem was solved with the computer and the result α, β, lnA and standard error α, standard error β are as follows.

Result / Sector	α	β	lnA	Standard Error of α	Standard Error of β
Industrial	0.6860636	0.3796471	1.829266	0.00891	0.035
Services	0.6352615	0.489937	2.411597	0.05817	0.22935
Agriculture	0.8196489	0.01021405	4.658195	0.11169	0.33476

3. <u>Level of Confidence</u>

The α, β and lnA were computed. In order to use these data to estimate production function for each year in industrial, agriculture and services, it is necessary to know the level of confidence. To compute the level of confidence, the same procedure was used as presented in section (C.3) in this chapter. The result are as follows:

Test / Sector	$\frac{\alpha}{\text{Standard Error of } \alpha}$	Minimum Level of Confidence	$\frac{\beta}{\text{Standard Error of } \beta}$	Minimum Level of Confidence
Industrial	$\frac{0.6860636}{0.00891} = 76.99$	99%	$\frac{0.3796471}{0.035} = 10.8$	99%
Services	$\frac{0.6352615}{0.05817} = 10.92$	99%	$\frac{0.489937}{0.22935} = 2.14$	88%
Agriculture	$\frac{0.8196489}{0.11169} = 7.34$	99%	$\frac{0.01021405}{0.33476} = 0.3$	Very low

β for agriculture sector has very low confidence level for example over 50% confidence level is not significant from zero. It was concluded that β for agriculture sector is equal to zero.

E. COMPUTING RATE OF RETURN

The α, β and A were computed for agriculture industrial and services which can be used to write production function for each year for these three sectors.

The rate of return to capital or labor can be computed by taking the derivative of production function with respect to capital or labor respectively. The production function is:

$$Q = A\ K^{\alpha}\ L^{\beta}$$

If it is assumed that the rate of return to capital is ρ, then the ρ is given by taking the derivative of output (Q) with respect to capital (K), which is α times constant A, times capital (K) to (α-1) power times labor (L) to β power, it can be written as:

$$\rho = \frac{dQ}{dK} = \alpha A K^{\alpha-1} L^{\beta}$$

This formula can be used to compute rate of return for each year for the three sectors. The easiest way to compute rate of return is to take the logarithm of both sides and after computing log ρ, then taking anti log ρ to obtain rate of return. For example, the natural log of rate of return equals to natural log constant A, plus natural log α plus (α-1) times natural log capital, plus β times natural log labor, that is:

$$\ln\rho = \ln\alpha + \ln A + (\alpha - 1)\ \ln K + \beta \ln L$$

consider the right side of the formula. The lnK and lnL is changed every year because labor and capital is changing, but the rest are constant. Using the figure for α, β and A which was computed before. The following three formulas can be used to compute rate of return for industrial, services and agriculture.

1. <u>Industrial</u>

$$\ln\rho = 1.452481056 + (0.3796471)\ \ln L - (0.3139364)\ \ln K \tag{4.3}$$

2. <u>Services</u>

$$\ln\rho = 1.957878446 + (0.489937)\ \ln L - (0.3647385)\ \ln K \tag{4.4}$$

3. <u>Agriculture</u>

$\beta = 0$ then

$$\ln\rho = 4.459315799 - (0.1803511)\ \ln K \tag{4.5}$$

The rate of return is computed for industrial, services and agriculture by using the formulas (4.3), (4.4), (4.5) with the data is in Tables 10, 11, 12 and the result for each year in these three sectors are shown in Tables 13, 14, 15 in the Appendix.

F. ANALYSIS AND POLICY IMPLICATION

The rate of return for industrial, services and agriculture has been computed. The accuracy of these rates is dependent on the accuracy of data and information which is available. Another problem is change in technology which is assumed to be fixed during this period.
If more data was obtained and broken down for each sector, for example industrial to mining, manufacturing and construction then better results might be obtainable. A lot of factors must be considered. Some of these are presented in the following subsection.

1. <u>Diminishing Rate of Return</u>

If equal increments of an input are added and the quantities of other inputs held constant, then the resulting increments of product will decrease beyond some point. For example if the quantity of labor increases and the quantity of capital is held constant. The return to labor decreases. The law of diminishing return is applied where the proportion of input change for example if the proportion of labor to capital increases then the return to labor decrease. Even in the long run when both factors are variable a kind of diminishing return may be obtained even where both factors increase proportionately.

It can be concluded that if the capital stock is increased in each sector, the rate of return decreases in the same sector. It can be seen from talbe 13, 14, 15 in Appendix. For this reason it may be required to adjust rate of return and social discount rate each year.

2. <u>Resource Allocation</u>

The statistical work which is done through this chapter has a very important role in economic analysis and investment decision whether in private or public sector.

a. Private Sector

The correct investment decision is to allocate the resources which give the highest return or to invest in the project which yeilds the highest rate of return. If the rate of return has not been computed how can it be determined that the investment is right or wrong. If the rate of return is not computed a correct investment decision cannot be made.

b. Public Sector

The goal of public investment is to gain maximum social welfare. If the rate of return in private sector is higher than public

sector it is socially beneficial to retain the resources in the private sector. In contrast if the government project gives higher rate of return than private then it gives more benefit to society if the resource is withdrawn from private sector and invested in the public sector.

The rate of return tells us correctly which project must be taken.

The social discount rate tell us when the resources must be transferred from one sector to another. In other words, rate of return determines how the resources must be allocated between project within private or public sector, but the social discount rate determines how the resource must be allocated between private and public sector.

As explained in chapter 3, the social discount rate is dependent on the rate of return in the private sector. If the rate of return is not computed, it is not possible to compute the social discount rate.

The social discount rate and rate of return which are keys to the optimal resource allocation can be obtained through statistical work which was presented throughout this chapter.

c. Transferring the Capital

In a society where the resources gives different rate of return, in other words, if the market is imperfect, then the government may control the economy to provide the maximum social gain by transferring the resources from lower productivity sector to higher productivity sector.

If the capital is withdrawn from a sector which gives 30% rate of return and invested in a sector which gives 50% rate of return then the society gives up $ 1.30 for $ 1.50. The benefit to society

exceeds the cost. As the statistical analysis shows, the return to capital in the agriculture sector is higher than in the services section, and the services sector is higher than the industrial sector.

For higher economic growth or to gain maximum social benefit. The government may transfer the resources from industrial to agriculture sector. For example, tax industrial at a higher rate than services and services higher than agriculture sector. If the resources are available, the priority may be given to the agriculture sector.

G. SUMMARY

The rate of return in private sector determines the social discount rate. The rate of return can be computed from production functions. One of the methods which can be used to estimate production function is the Cobb-Douglas production function.

By using historical data and Cobb-Douglas production function, the rate of return is computed for three sectors in Iran. The statistical analysis which is presented in this chapter is required for resource allocation decisions. The optimal resource allocation is to transfer the resources from lower to the higher productivity area which results in maximum social benefit, and leads to economic growth.

If the rate of return has not been measured it is not possible to determine where the resources give the maximum return.

V. CONCLUSION

It is understood that the optimal resource allocation provides the maximum social benefit or maximum rate of economic growth.

It was shown how taxes, risk and uncertainty produce discrepancies in the rate of return earned by various parts of the private sector. This means that capital simply is not allocated optimally within sectors. Society could obviously benefit by a transfer of capital from areas in which its rate of returns is relatively low to other parts of the economy offering a higher social return. If the resources produced say ρ percent rate of return in the private sector, then the resources should be transferred to the public project if that project yields a rate of return greater than ρ percent. But what is the key which determines exactly where the resources must be allocated? Obviously the discount rate is the one which calls for a transfer of resources from a use in which yield is relatively low to one where return is comparatively high.

The discount rate tells us exactly how the resources must be allocated within and between private and public sectors. If the discount rate has not been computed, then it is impossible to determine whether the resources have been used efficiently or not.

Using an incorrect discount rate will lead to decisions that reduce the social welfare. On the other hand, using the correct discount rate provides the optimal resource allocation, which leads to rapid economic growth.

There is no doubt that the role of discount rate is very important in the economic analysis. A high rate of economic growth in Iran

indicates that the resources have been allocated correctly. But this growth rate can be improved by using the appropriate discount rate.

The maximum rate of economic growth can be obtain from optimal resource allocation by using the correct discount rate.

Through this presentation a method was introduced which can be used to compute the rate of return in different sectors of economy and the formula for computing the social discount rate.

The rate of return in industrial, services and agriculture sectors in Iran was computed. These statistical analyses and procedures can be used to compute the rate of return in all businesses. These rates, which determine the social discount rate, tell how the resources can be allocated to obtain the maximum economic growth.

APPENDIX

TABLE 1

GROSS NATIONAL PRODUCT
BY THE ECONOMIC SECTORS

	PERIOD	INDUSTRIAL	SERVICES	AGRICULTURE
(1964)	2523	72.8	156	110.6
	2524	86.1	178.3	120
	2525	95.5	195.3	121.7
	2526	111.8	211.5	128.4
	2527	130.3	243.2	139.6
	2528	150.3	273.2	147.8
	2529	168.1	314.7	160.6
	2530	199.1	364.5	172.7
	2531	246.5	446.2	201.8
	2532	332.6	554.8	235
	2533	464.3	825.6	304.8
(1975)	2534			333.9

* Amount (billion rials)

Year starts on 21 March

TABLE 2

GROSS DOMESTIC FIXED
CAPITAL FORMATION

	PERIOD	INDUSTRIAL	SERVICES	AGRICULTURE
(1965)	2524	43.7	26.8	5.7
	2525	48.8	28.4	5.6
	2526	60.8	38.6	8.5
	2527	70.8	43.5	8.7
	2528	74.1	50.4	10.6
	2529	83.3	58.6	10.8
	2530	111.3	73.6	15.1
	2591	138.5	94.9	25.1
	2532	173	129.9	28.4
(1974)	2533	266.6	192.8	51.4

* Amount (billion rials)

TABLE 3

EMPLOYMENT BY THE THREE
ECONOMIC SECTORS

	PERIOD	INDUSTRIAL	SERVICES	AGRICULTURE
(1965)	2524	--	--	--
	2525	1984	2076	3486
	2526	1993	2020	3861
	2527	--	--	--
	2528	--	--	--
	2529	--	--	--
	2530	2219	2263	3989
(1972)	2531	2730	2740	4417.9

* Number (1,000 persons)

TABLE 4

CHANGE OF OUTPUT AND CHANGE OF CAPITAL
BETWEEN TWO TIME PERIODS IN THE INDUSTRIAL

	PERIOD	CHANGE OF OUTPUT	CHANGE OF CAPITAL
		$Q_t - Q_{t-1}$	$K_t - K_{t-1} = I_t$
(1965)	2524	86.1 - 72.8 = 13.3	43.7
	2525	95.5 - 86.1 = 9.4	48.8
	2526	111.8 - 95.5 = 16.3	60.8
	2527	130.3 - 111.8 = 18.5	70.8
	2528	150.3 - 130.3 = 20	74.1
	2529	168.1 - 150.3 = 17.8	83.3
	2530	199.1 - 168.1 = 31	111.3
	2531	246.5 - 199.1 = 47.4	138.5
	2532	332.6 - 246.5 = 86.1	173
(1974)	2233	464.3 - 332.6 = 131.7	266.6

TABLE 5

CHANGE OF OUTPUT AND CHANGE OF CAPITAL BETWEEN TWO TIME PERIODS IN THE SERVICES

PERIOD		CHANGE OF OUTPUT	CHANGE OF CAPITAL
		$Q_t - Q_{t-1}$	$K_t - K_{t-1} = I_t$
(1965)	2524	178.3 - 156 = 22.3	26.8
	2525	195.3 - 178.3 = 17	28.4
	2526	211.5 - 195.3 = 16.2	38.6
	2527	243.2 - 211.5 = 31.7	43.5
	2528	273.2 - 243.2 = 30	50.4
	2529	314.7 - 273.2 = 41.5	58.6
	2530	364.5 - 314.7 = 49.8	73.6
	2531	446.2 - 364.5 = 81.7	94.9
	2532	554.8 - 446.2 = 108.6	129.9
(1974)	2533	825.6 - 554.8 = 270.8	192.8

TABLE 6

CHANGE OF OUTPUT AND CHANGE OF CAPITAL
BETWEEN TWO TIME PERIODS IN THE AGRICULTURE

PERIOD		CHANGE OF OUTPUT $Q_t - Q_{t-1}$	CHANGE OF CAPITAL $K_t - K_{t-1} = I_t$
(1965)	2524	120 - 110.6 = 9.4	5.7
	2525	121.7 - 120 = 1.7	5.6
	2526	128.4 - 121.7 = 6.7	8.5
	2527	139.6 - 128.4 = 11.2	8.7
	2528	147.8 - 139.6 = 8.2	10.6
	2529	160.6 - 147.8 = 12.8	10.8
	2530	172.7 - 160.6 = 12.1	15.1
	2531	201.8 - 172.7 = 29.1	25.1
	2532	235 - 201.8 = 38.2	28.4
(1974)	2533	304.8 - 235 = 69.8	51.4

TABLE 7

CAPITAL STOCK OF INDUSTRIAL SECTOR

	PERIOD	OUTPUT	CAPITAL
		Q_t	$K_t = K_{t-1} + I_t$
(1965)	2524	86.1	180.2816406 *
	2525	95.5	229.0816
	2526	111.8	389.8816
	2527	130.3	360.6816
	2528	150.3	434.7816
	2529	168.1	518.0816
	2530	199.1	629.3816
	2531	246.5	707.8816
	2532	332.6	940.8816
(1974)	2533	464.3	1207.4816

* $K = a + bq = 27.68265 + 1.772346\ (86.1) = 180.2816406$

TABLE 8

CAPITAL STOCK OF SERVICES SECTOR

PERIOD	OUTPUT Q_t	CAPITAL $K_t = K_{t-1} + I_t$
(1965) 2524	178.3	146.538602 *
2525	195.3	174.938602
2526	211.5	213.538602
2527	243.2	257.038602
2528	273.2	307.438602
2529	314.7	366.038602
2530	364.5	439.638602
2531	446.2	534.538602
2532	554.8	664.438602
(1974) 2533	825.6	857.238602

* $K = a + bq = 29.97487 + 0.6537506\ (178.3) = 146.538602$

TABLE 9

CAPITAL STOCK OF AGRICULTURE SECTOR

PERIOD		OUTPUT Q_t	CAPITAL $K_t = K_{t-1} + I_t$
(1965)	2524	120	87.525647 *
	2525	121.7	93.125644
	2526	128.4	101.625647
	2527	139.6	110.325647
	2528	147.8	120.925647
	2529	160.6	131.725647
	2530	172.7	146.825647
	2531	201.8	171.925647
	2532	235	200.325647
(1974)	2533	304.8	251.725647

* $K = a + bQ = 3.370967 + 0.701289\ (120) = 87.525647$

TABLE 10

Q_t, $\ln Q_t$, K_t, $\ln K_t$, L_t, $\ln L_t$ OF INDUSTRIAL SECTOR

	PERIOD	Q_t	$\ln Q_t$	K_t	$\ln K_t$	L_t	$\ln L_t$
(1966)	2525	95.5×10^9	25.28239208	299.0816×10^9	26.15734411	1984×10^3	14.50062557
	2526	111.8×10^9	25.43997740	389.8816×10^9	26.39273840	1993×10^3	14.50515160
	2527	130.3×10^9	25.59310532	360.6816×10^9	26.61126141	--	--
	2528	150.3×10^9	25.73589913	434.7816×10^9	26.79810967	--	--
	2529	168.1×10^9	25.84782488	518.0816×10^9	26.97339860	--	--
	2530	199.1×10^9	26.01707305	629.3816×10^9	27.16800359	2219×10^3	14.61256720
(1972)	2531	246.5×10^9	26.23062783	767.8816×10^9	27.36690139	2730×10^3	14.81981217

TABLE 11

Q_t, $\ln Q_t$, K_t, $\ln K_t$, L_t, $\ln L_t$ OF SERVICES SECTOR

	PERIOD	Q_t	$\ln Q_t$	K_t	$\ln K_t$	L_t	$\ln L_t$
(1966)	2525	193.3×10^9	25.99780267	174.938602×10^9	25.8877009	2076×10^3	14.54595352
	2526	211.5×10^9	26.07749084	213.538602×10^9	26.08708343	2020×10^3	14.51860807
	2527	243.2×10^9	26.21714999	257.038602×10^9	26.27249211	--	--
	2528	273.2×10^9	26.33346996	307.438602×10^9	26.45154124	--	--
	2529	314.7×10^9	26.47488564	366.038602×10^9	26.62600463	--	--
	2530	364.5×10^9	26.62179239	439.638602×10^9	26.80921887	2263×10^3	14.63220192
(1972)	2531	446.2×10^9	26.82403312	534.538602×10^9	27.00466979	2740×10^3	14.82348648

TABLE 12

Q_t, $\ln Q_t$, K_t, $\ln K_t$, L_t, $\ln L_t$ OF AGRICULTURE SECTOR

	PERIOD	Q_t	$\ln Q_t$	K_t	$\ln K_t$	L_t	$\ln L_t$
(1966)	2525	121.7×10^9	25.52482489	93.125647×10^9	25.25721564	3486×10^3	15.06426551
	2526	128.4×10^9	25.57841623	101.625647×10^9	25.34456177	3861×10^3	15.16643678
	2527	139.6×10^9	25.66204703	110.325647×10^9	25.42670226	--	--
	2528	147.8×10^9	25.719112585	120.925647×10^9	25.51844171	--	--
	2529	160.6×10^9	25.80218264	131.725647×10^9	25.60398717	--	--
	2530	172.7×10^9	25.87482182	146.825647×10^9	25.71251165	3989×10^3	15.19905113
(1972)	2531	201.8×10^9	26.03054294	171.925647×10^9	25.87032794	4417.9×10^3	15.30117604

TABLE 13

RATE OF RETURN (MARGINAL PRODUCTIVITY OF CAPITAL MP_K) OF INDUSTRIAL SECTOR

$\alpha = 0.6860636$ $\quad\quad$ $\ln\alpha = -0.3767849442$

$\beta = 0.3796471$ $\quad\quad$ $\ln A = 1.829266$

$Q = AK^{\alpha}L^{\beta}$ $\quad\quad$ $\rho = \frac{dQ}{dK} = \alpha AK^{\alpha-1}L^{\beta}$

$\ln\rho = \ln\alpha + \ln A + \beta \ln L + (\alpha-1)\ln K$

PERIOD

(1966) 2525 $\ln\rho = 1.452481056 + (0.3796471)(14.50062557) - (0.3139364) \times (26.15734411) = -1.254140942$

$\rho = 28.532\%$

2526 $\ln\rho = 1.452481056 + (0.3796471)(14.50515160) - (0.3139364) \times (26.39273840) = -1.326321483$

$\rho = 26.545\%$

2530 $\ln\rho = 1.452581056 + (0.3796471)(14.6125672) - (0.3139364) \times (27.16800359) = -1.528825425$

$\rho = 21.679\%$

(1972) 2531 $\ln\rho = 1.452581056 + (0.3796471)(14.81981217) - (0.3139364) \times (27.36690139) = -1.512586733$

$\rho = 22.034\%$

Average rate of return = 24.7%

TABLE 14

RATE OF RETURN (MARGINAL PRODUCTIVITY OF CAPITAL MP_K) OF SERVICES SECTOR

$\alpha = 0.6352615$ $\qquad \ln\alpha = -0.453718554$

$\beta = 0.489937$ $\qquad \ln A = 2.411597$

$Q = AK^{\alpha}L^{\beta}$ $\qquad \rho = \frac{dQ}{dK} = \alpha AK^{\alpha-1}L^{\beta}$

$$\ln\rho = \ln\alpha + \ln A + (\alpha-1)\ln K + \beta\ln L$$

PERIOD

(1966) 2525 $\ln\rho = 1.957878446 + (0.489937)(14.54595352) - (0.3647385)(25.8877009) = -0.3577619189$

$\rho = 69.924\%$

2526 $\ln\rho = 1.957878446 + (0.489937)(14.51860807) - (0.3647385)(26.08708343) = -0.4438819516$

$\rho = 64.1\%$

2530 $\ln\rho = 1.957878446 + (0.489937)(14.63220192) - (0.3647385)(26.80921887) = -0.6516187187$

$\rho = 52.12\%$

(1972) 2531 $\ln\rho = 1.957878446 + (0.489937)(14.82346848) - (0.3647385)(27.00466979) = -0.6291986295$

$\rho = 53.3\%$

Average rate of return = 59.86%

TABLE 15

RATE OF RETURN (MARGINAL PRODUCTIVITY OF CAPITAL MP_K) OF AGRICULTURE SECTOR

$\alpha = 0.8196489$ $\quad\quad$ $\ln\alpha = -0.1988792011$

$\beta = 0$ $\quad\quad$ $\ln A = 4.658195$

$Q = AK^{\alpha}L^{\beta}$ $\quad\quad$ $\rho = \frac{dQ}{dK} = \alpha AK^{\alpha-1}L^{\beta}$

$$\ln\rho = \ln\alpha + \ln A + (\alpha-1)\ \ln K$$

PERIOD

(1966) 2525 $\quad \ln\rho = 4.459315799 - (0.1803511)(25.25721546)$

$\ln\rho = -0.0958507921 \quad\quad \rho = 90.86\%$

2526 $\quad \ln\rho = 4.459315799 - (0.1803511)(25.3445677)$

$\ln\rho = -0.1116048647 \quad\quad \rho = 89.44\%$

2530 $\quad \ln\rho = 4.459315799 - (0.1803511)(25.71251165)$

$\ln\rho = -0.1779639608 \quad\quad \rho = 83.7\%$

(1972) 2531 $\quad \ln\rho = 4.459315799 - (0.1803511)(25.87032794)$

$\ln\rho = -0.2064263023 \quad\quad \rho = 81.35\%$

Average rate of return = 86.34%

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c.1 Determining discount rate in Iran and its role in resources allocation.